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"JP 01-037883 (1989) (Yamamoto et al.)"

Partial English Translation of
Japanese Patent Laying-Open No. 64-37833

Translation 1

In the above single crystal growth condition where the background of the carbon concentration in the crystal is small, a method set forth in the following can be considered in order to dope a predetermined amount of carbon into the crystal.

(1) Method of adding carbon directly into raw material

In the LEC method and HB method, fine powder of high-purity carbon is weighed, and a predetermined amount thereof is admitted into a pBN crucible or pBN boat. Also, Ga, As and B_2O_3 are added and melted. Since a predetermined amount of carbon is dissolved in the GaAs melt, a predetermined amount of carbon according to the segregation coefficient can be included in the crystal by pulling up a single crystal from the solution.

(2) Method by applying a carbon coating on crucible

Liquid carbon compound such as alcohol, ethanol, and the like is admitted in a pBN crucible or a pBN boat. The same is thermal decomposed, or by CVD using CCl_4 and the like, a coat of carbon is applied on the inner sidewall of the crucible. By producing GaAs melt using a crucible or boat with a carbon

coating, the carbon at the surface of the vessel is dissolved into the GaAs melt. By pulling up the single crystal from the melt, a predetermined amount of carbon according to the segregation coefficient can be included in the crystal.

(3) Method of mixing a predetermined amount of gaseous carbon compound in ambient gas

In growing a single crystal, the gas of Ar, N₂ and the like is used in the LEC method. In the HB method, such gas is not used, a vacuum sealed tube is used instead. In either of these methods, gaseous carbon compound such as CO₂, CH₄ and C₂H₆ and the like is directed into ambient gas of constant amount or into a vacuum sealed tube, whereby carbon is doped into the melt by the reaction between the carbon compound and the GaAs melt. As a result, carbon can be doped into the single crystal that is to be grown.

Translation 2

[Embodiment]

Using a high pressure single crystal pull up device according to the LEC method, a single crystal of GaAs was grown. The crucible used in the furnace and the graphite-made component called hot zone were previously baked in vacuum at 1500°C. The high purity product of 7N (99.99999%) of materials Ga and As were used. Graphite powder of high purity were

admitted into a pBN crucible of 6 inch in diameter so that the carbon concentration in the GaAs melt was approximately $4 \times 10^{15} \text{ cm}^{-3}$. Here, the amount to be added is determined taking into consideration the segregation coefficient of carbon. Then, Ga and As were inserted. Then, B_2O_3 serving as a sealing agent was admitted. These were directly combined in the furnace, and then melted, and a seed crystal was dipped and then pulled up at the speed of 9 mm/h. The ambient at the time of growth was Ar gas and 20 atm. Following the crystal growth, the crystal was cooled down to room temperature taking approximately 8 hours.

The resistivity of the grown GaAs single crystal of 2-3 inches in diameter had a high resistance of at least $10^7 \Omega \cdot \text{cm}$ from the upper to lower portion of the crystal.